PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2001-189440**
(43)Date of publication of application : **10.07.2001**

(51)Int.Cl. **H01L 27/14**
H01L 27/148
H01L 31/0232
H04N 5/335

(21)Application number : **2000-000376**
(22)Date of filing : **05.01.2000**

(71)Applicant : **MATSUSHITA ELECTRONICS INDUSTRY CORP**
(72)Inventor : **YOSHIGAMI TAKAYUKI**
CHATANI YOSHIKAZU
TERAKAWA SUMIO

(54) SOLID-STATE IMAGE PICKUP DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a solid-state image pickup device which is improved in light condensing rate by a method, where an optical waveguide film for guiding a part of incident light to a light receiving part is provided.
SOLUTION: A solid-state image pickup device is equipped with a semiconductor substrate 1, a light receiving part 3 and a charge transfer part 4 formed inside the semiconductor substrate 1, a light shielding film 8 formed above the semiconductor substrate 1, so as to cover the charge transfer part 4 and not to cover at least a part of the light receiving part 3, and an optical waveguide film 10 formed above the light-blocking film 8, where an optical waveguide film 10 is a multilayered film composed of a first layer 11, a second layer 12, and a third layer 13 laminated above the substrate 1 in this sequence, and the first and third layer, 11 and 13 are set different from the second layer 12 in refractive index, and the first layer 11 is equipped with at least an opening at a part, corresponding to the light receiving part 3.

LEGAL STATUS

[Date of request for examination]	30.08.2001
[Date of sending the examiner's decision of rejection]	

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3485304
[Date of registration]	24.10.2003
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]
[Claim 1] It has a semi-conductor substrate, the light sensing portion formed in said semi-conductor substrate, and the optical guided wave film formed above said semi-conductor substrate. The solid state camera with which said optical guided wave film is the multilayers the 1st layer, the 2nd layer, and the 3rd layer come to carry out a laminating to order from said semi-conductor substrate side, it has the refractive index from which the 1st layer and said said 3rd layer differ in said 2nd layer, and said 1st layer has opening into the part corresponding to said light sensing portion at least.
[Claim 2] Furthermore, the solid state camera according to claim 1 with which it has the light-shielding film formed above said semi-conductor substrate so that the charge transfer section formed in said semi-conductor substrate and said charge transfer section may be covered and said a part of light sensing portion [at least] may not be covered, and said optical guided wave film is formed above said light-shielding film.
[Claim 3] The solid state camera according to claim 1 or 2 with which said 3rd layer has said refractive index higher than the 2nd layer.
[Claim 4] The solid state camera according to claim 1 to 3 with which said 3rd layer has opening into the part corresponding to said light sensing portion.
[Claim 5] A solid state camera according to claim 4 with larger opening formed in said 1st layer than opening formed in said 3rd layer.
[Claim 6] The solid state camera according to claim 1 to 5 the 1st layer and said said whose 3rd layer are a silicon nitride or a silicon nitriding oxide film and said whose 2nd layer is a silicon nitriding oxide film or silicon oxide.
[Claim 7] Said solid state camera according to claim 1 to 6 with which the 1st layer and said 3rd layer are formed in abbreviation parallel.
[Claim 8] The solid state camera according to claim 1 to 7 with which said 1st layer sets above said light sensing portion, and is crooking or curving to said semi-conductor substrate side.
[Claim 9] The solid state camera according to claim 1 to 8 with which said optical guided wave film is formed on the interlayer insulation film, and said interlayer insulation film

has a crevice into the part corresponding to said light sensing portion.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a solid state camera.
[0002]
[Description of the Prior Art] In recent years, the sensibility fall to which ****** to which detailed-ization of a pixel is advanced in order to attain a miniaturization and high-resolution-izing of an optical system system originated in reduction of the optical exposure per pixel in connection with this in the solid state camera poses a problem.
[0003] In order to solve the above-mentioned problem, the method of raising the rate of condensing to a light sensing portion is proposed by preparing a lens on chip in each pixel. Drawing 4 is the sectional view showing the structure of such a solid state camera. In this solid state camera, a light sensing portion 23 and the charge transfer section 24 are formed in the well 22 formed in the semi-conductor substrate 21, and the transfer electrode 26 is formed through the insulator layer 25 on the charge transfer section 24. The laminating of the 1st interlayer insulation film 27, light-shielding film 28, 2nd interlayer insulation film 29, passivation film 30, flattening film 34, and color filter 35 is carried out to the semi-conductor substrate 21 upper part in this sequence, and the lens 36 on chip is formed on the color filter 35. The lens 36 on chip is a convex lens designed so that incident light could be condensed to a light sensing portion 23.
[0004]
[Problem(s) to be Solved by the Invention] However, in the above-mentioned solid state camera, although it can condense to a light sensing portion about the light which carried out incidence to the lens 36 on chip, it cannot condense about the light 37 which carried out incidence to the gap of on-chip lens 36 comrades. This had become a problem when aiming at further improvement in the rate of condensing.
[0005] This invention aims at offering the solid state camera of the high sensitivity which raised the rate of condensing.
[0006]
[Means for Solving the Problem] In order to attain said purpose, the solid state camera of this invention It has a semi-conductor substrate, the light sensing portion formed in said semi-conductor substrate, and the optical guided wave film formed above said semi-conductor substrate. Said optical guided wave film is the multilayers the 1st layer, the 2nd layer, and the 3rd layer come to carry out a laminating to order from said semi-conductor substrate side, it has the refractive index from which the 1st layer and said said 3rd layer differ in said 2nd layer, and said 1st layer has opening into the part corresponding to said light sensing portion at least.
[0007] By making it such a configuration, it can transmit catching the light which is going to carry out incidence by the optical guided wave film to fields other than a light sensing portion, and making them carry out multiple reflection by the interface of the 1st layer and the 2nd layer, and the interface of the 2nd layer and the 3rd layer, and can lead

to a light sensing portion. Consequently, the rate of condensing to a light sensing portion can be raised, and the sensibility of a solid state camera can be raised. In addition, the optical guided wave film transmits light by reflection within the film, and means the film which has the function drawn to a predetermined part.
[0008] In said solid state camera, it can consider as the structure equipped with the light-shielding film formed above said semi-conductor substrate so that the charge transfer section formed in said semi-conductor substrate and said charge transfer section may be covered further and said a part of light sensing portion [at least] may not be covered, and said optical guided wave film can be formed above said light-shielding film.
[0009] Moreover, in said solid state camera, it is desirable that said 3rd layer has said refractive index higher than the 2nd layer. It is because the light which carries out incidence to the 2nd layer from the 3rd layer can be made refracted in the direction of a light sensing portion, so the rate of condensing can be raised more certainly.
[0010] Moreover, in said solid state camera, it is desirable that said 3rd layer has opening into the part corresponding to said light sensing portion. In the light sensing portion upper part, it is because it is avoidable that light reflects by the interface of said 3rd layer and the film formed on it, so the rate of condensing can be raised more certainly.
[0011] Moreover, in said solid state camera, it is desirable that opening formed in said 1st layer is larger than opening formed in said 3rd layer. It is because the light caught by the optical guided wave film can be certainly drawn to a light sensing portion.
[0012] Moreover, in said solid state camera, the 1st layer and said said 3rd layer are a silicon nitride or a silicon nitriding oxide film, and it is desirable that said 2nd layer is a silicon nitriding oxide film or silicon oxide.
[0013] Moreover, in said solid state camera, said thing [that the 1st layer and said 3rd layer are formed in abbreviation parallel] is desirable. It is because the transmission efficiency of the light by the optical guided wave film improves.
[0014] Moreover, in said solid state camera, it is desirable that said 1st layer sets above said light sensing portion, and is crooking or curving to said semi-conductor substrate side. It is because the light caught by the optical guided wave film can be more certainly led to a light sensing portion.
[0015] Moreover, in said solid state camera, said optical guided wave film is formed on the interlayer insulation film, and it is desirable that said interlayer insulation film has a crevice into the part corresponding to said light sensing portion. It is because the optical guided wave film can be crooked or incurvated easily.
[0016]
[Embodiment of the Invention] Drawing 1 is the sectional view showing an example of the structure of the solid state camera concerning this invention.
[0017] In this solid state camera, in the well 2 of the semi-conductor substrate 1, it is formed so that the light sensing portion 3 for performing photo electric conversion and the charge transfer section 4 for transmitting the charge produced in the photo electric conversion of a light sensing portion 3 may adjoin mutually. On the charge transfer section 4, the transfer electrode 6 is formed through the insulator layer 5, and the 1st interlayer insulation film 7 is formed so that the transfer electrode 6 may be covered. The light-shielding film 8 is formed on the 1st interlayer insulation film 7. A light-shielding film 8 is film which covers the light which carries out incidence to fields other than light sensing portion 3, covers the transfer electrode 6 and has opening into the part

corresponding to a light sensing portion 3. The 2nd interlayer insulation film 9 is formed on the light-shielding film 8. The 2nd interlayer insulation film has the crevice into the part corresponding to a light sensing portion 3. The optical guided wave film 10 is formed on the 2nd interlayer insulation film 9. Furthermore, on the optical guided wave film 10, the flattening film 14, the color filter 15, and the lens 16 on chip are formed in this sequence.

[0018] About each component except the optical guided wave film 10, the same structure and same ingredient as what is used from the former are employable.

[0019] Hereafter, the optical guided wave film 10 is explained. the optical guided wave film 10 -- the 2nd interlayer insulation film 9 top -- the 1st -- layer 11 and the 2nd -- layer 12 -- and the 3rd layer, the laminating of 13 is carried out to order, and it is constituted.

[0020] the refractive index of each class of the optical guided wave film 10 -- the 1st -- layer 11 and the 2nd -- the interface of layer 12 -- and it is set up so that the 3rd layer of the 2nd layer of light may reflect in the interface of 13 with 12. namely, the 1st -- layer 11 -- and the 3rd layer of the 2nd layer of the refractive index of 13 is different from the refractive index of 12 -- it is set up so that it may become it is desirable and higher than it.

[0021] As for at least one layer of the optical guided wave film 10, it is desirable to consist of ingredients containing hydrogen. By carrying out processing accompanied by heating after optical guided wave film formation, it is because the hydrogen contained in the optical guided wave film can be emitted, termination of the dangling bond which exists in a semi-conductor substrate front face from this hydrogen can be carried out and dark current generating can be controlled. As such an ingredient, the silicon nitride and silicon nitriding oxide film which were formed of plasma chemistry vapor growth (henceforth the "PCVD method") are mentioned.

[0022] Moreover, at least one layer of the optical guided wave film 10 has a comparatively high consistency, and it is desirable to consist of ingredients which can control diffusion of impurities, such as water. It is because the optical guided wave film can be used as passivation film. As such an ingredient, a silicon nitride and a silicon nitriding oxide film are mentioned.

[0023] From the above thing, the 1st layer of the 1st layer of 11 and the gestalt which constitutes 13 [layer / 3rd] from a silicon nitriding oxide film, and constitutes 12 [layer / 2nd] from silicon oxide are mentioned as a desirable gestalt of the optical guided wave film 10 with 11 and the gestalt which constitutes 13 [layer / 3rd] from a silicon nitride, and constitutes 12 [layer / 2nd] from a silicon nitriding oxide film or silicon oxide.

[0024] In this case, the 1st layer, the range of 11 and the refractive index in the light region of 13 is 1.46-2.1, and the range of them is 1.8-2.0 preferably the 3rd layer. Moreover, the 2nd layer, the range of the refractive index in the light region of 12 is 1.46-1.8, and the range of it is 1.46-1.47 preferably. In addition, 13 [layer / 1st / layer / 3rd] does not need to be 11 and the same refractive index.

[0025] moreover, the 1st -- layer 11 -- 12 and the 2nd layer also of also constituting the whole of 13 [layer / 3rd] from a silicon nitriding oxide film are also possible. In this case, the 1st layer of a refractive index can be made different by making different the rate of 11 and Si-N [in / the 2nd layer / the 3rd layer / at 12 / with 13 / a silicon nitriding oxide film] association, and Si-O association. In addition, in a silicon nitriding oxide film, a refractive index becomes high, so that the rate of Si-N association increases, and a refractive index becomes low, so that the rate of Si-O association increases.

[0026] It is the part corresponding to a light sensing portion 3 of the optical guided wave film, and the 1st layer of opening is formed in the part corresponding to opening formed in the light-shielding film 8 11. In addition, the 1st layer, although especially opening of 11 is not limited, it is desirable that it is smaller than opening of a light-shielding film 8.
[0027] Moreover, as shown in drawing 1 , as for the optical guided wave film 10, it is desirable to meet the configuration of the crevice formed in the 2nd interlayer insulation film 9, and to crook or curve to the semi-conductor substrate side. In this case, the curvature of the curve in the optical guided wave film 10 or the include angle of crookedness is so desirable that it is large from the point of improvement in the rate of condensing.
[0028] Next, an example of the manufacture approach of this solid state camera is explained.
[0029] First, in the n-type-semiconductor substrate 1, p mold impurities, such as boron, are poured in and p mold well 2 is formed. Next, in p mold well 2, n mold impurities, such as Lynn, are poured in and a light sensing portion 3 and the charge transfer section 4 are formed. On the semi-conductor substrate 1, after forming the insulator layer 5 which consists of silicon oxide by the oxidizing [thermally] method, by the chemical-vapor-deposition method (henceforth a "CVD method"), polish recon is formed, patterning of this is carried out, and the transfer electrode 6 is formed. Next, with the oxidizing [thermally] method or a CVD method, the 1st interlayer insulation film 7 which consists of silicon oxide is formed so that the transfer electrode 6 may be covered. On the 1st interlayer insulation film 7, by the spatter, a tungsten or tungsten silicide is formed, patterning of this is carried out, and a light-shielding film 8 is formed.
[0030] Then, with a CVD method, the silicon oxide (henceforth "BPSG") which doped boron and Lynn is formed, and it considers as the 2nd interlayer insulation film 9 so that a light-shielding film 8 may be covered. Since membranes are formed by the front face on which the level difference resulting from a transfer electrode exists at this time, a crevice is formed in the part corresponding to a light sensing portion 3 at the 2nd interlayer insulation film 9. Next, the crevice of the 2nd interlayer insulation film 9 is processed on a curved surface by reflow processing by heating. In addition, reflow processing temperature and time amount can adjust the curvature of the curved surface of a crevice in the boron concentration of BPSG and the Lynn concentration, and a list.
[0031] Next, the optical guided wave film 10 is formed on the 2nd interlayer insulation film 9. First, after forming 11 [layer / 1st] and forming an etching mask by the photolithography method on 1st layer 11, 11 [layer / 1st] is etched and opening is formed. Then, it reaches 2nd layer 12 on 1st layer 11, and sequential membrane formation of 13 [layer / 3rd] is carried out. In addition, as etching, both isotropic etching and anisotropic etching are employable.
[0032] As the membrane formation approach of each class which constitutes the optical guided wave film 10, when forming a silicon nitride, the PCVD method is adopted, and when forming silicon oxide, a reduced pressure CVD method is adopted. moreover -- the case where a silicon nitriding oxide film is formed -- PCVD -- law is adopted. At this time, adjustment of the refractive index of a silicon nitriding oxide film is carried out by adjusting the flow rate of SiH_4 and NH_3 which are material gas, and N_2O. For example, when the flow rate of SiH_4 is set constant, if N_2O is increased, a refractive index will fall, and if NH_3 is increased, a refractive index will increase.

[0033] Silicon oxide is formed with a CVD method on the optical guided wave film 10, and by the chemical machinery grinding method, carry out flattening of the front face, and let it be the flattening film 14. Next, after forming a color filter 15 on the flattening film 14 by the photolithography method which used the color resist, the lens 16 on chip is formed. The lens 16 on chip applies the resin in which thermofusion is possible, and after it divides this so that it may correspond to each light sensing portion, it can form it by carrying out reflow processing by heating.
[0034] Drawing 2 is the sectional view showing another example of the solid state camera of this invention. In addition, in drawing 1 and drawing 2 , the same sign is given to the same part.
[0035] In the part corresponding to the light sensing portion 3 of the optical guided wave film 10, the 1st layer of this solid state camera is different not only from 11 but the solid state camera shown in drawing 1 the 2nd layer with 12 and the point that the 3rd layer of opening is formed also in 13. The 1st layer of opening of 11 is set up so that the 3rd layer may become larger than opening of 13. In addition, if this solid state camera removes the above-mentioned difference, it has the same structure as the solid state camera shown in drawing 1 .
[0036] When this solid state camera manufactures, the optical guided wave film 10 can be formed by the following two approaches.
[0037] The 1st approach is the approach of forming opening of each class using a respectively different etching mask. First, after forming 11 [layer / 1st] on the 2nd interlayer insulation film 9 and forming the 1st etching mask by the photolithography method on 1st layer 11, 11 [layer / 1st] is etched. Then, after forming 12 [layer / 2nd] on 1st layer 11 and forming the 2nd etching mask by the photolithography method on 2nd layer 12, 12 [layer / 2nd] is etched. Next, after forming 13 [layer / 3rd] on 2nd layer 12 and forming the 3rd etching mask by the photolithography method on 3rd layer 13, 13 [layer / 3rd] is etched. In addition, especially etching of each class cannot be limited and both isotropic etching and anisotropic etching can adopt it.
[0038] In this case, the 3rd layer of the 1st layer of opening of 11 can be adjusted more greatly than opening of 13 by making different the pattern formed in the 1st etching mask, and the pattern formed in the 3rd etching mask.
[0039] The 2nd approach is the approach of forming opening of each class using the same etching mask. first, the 2nd interlayer insulation film 9 top -- the 1st -- layer 11 and the 2nd -- layer 12 -- and 13 [layer / 3rd] is formed in this sequence. Next, an etching mask is formed by the photolithography method on 3rd layer 13. then, this etching mask -- using -- the 3rd -- layer 13 and the 2nd -- layer 12 -- and 11 [layer / 1st] is etched in this sequence.
[0040] In this case, the 3rd layer of the 1st layer of opening of 11 can be adjusted by adopting etching which can produce side etching more greatly than opening of 13. It is desirable to adopt the wet etching which is isotropic etching as such etching. Moreover, what is necessary is just to perform processing more mostly rather than etching a part for the thickness of the etched film exactly, i.e., over etching, using the etching gas which can fully secure selectivity between the etched film and the film which exists in the bottom of it, when adopting the dry etching which is anisotropic etching.
[0041] In addition, in manufacturing this solid state camera, about the membrane formation approach of each class which constitutes the optical guided wave film, and the

formation approach of each component except the optical guided wave film, the same approach as the case where the solid state camera shown in drawing 1 is manufactured is employable.
[0042] Moreover, in this solid state camera, it is also possible to consider as the structure of the optical guided wave film where 12 does not have the 2nd layer of opening. In this case, either [at least] the 2nd interlayer insulation film 9 or the flattening film 14 and the substantially equal thing of the refractive index of 12 are desirable the 2nd layer.
[0043] In drawing 1 and drawing 2 , although the gestalt by which the optical guided wave film was formed between the 2nd interlayer insulation film and the flattening film was illustrated, the formation part of the optical guided wave film will not be limited rather than a light-shielding film, especially if it is the upper part.
[0044] For example, as shown in drawing 3 , it is also possible to consider as the structure in which the 2nd layer of the optical guided wave film served also as the function as flattening film. That is, it considers as the structure where 12 [layer / 2nd] was formed so that 11 [layer / 1st] might be formed on the 2nd interlayer insulation film 9 which has a crevice into the part corresponding to a light sensing portion 3 and flattening of said crevice might be carried out on 1st layer 11, and 13 [layer / 2nd / layer / 3rd] was formed on the flat front face of 12, and things can be carried out. In this case, a color filter 15 can be formed on 3rd layer 13.
[0045] Moreover, in drawing 1 - drawing 3 , although the gestalt of the optical guided wave film in which the 1st layer curved at least in the light sensing portion upper part was shown, it is also possible to make the 1st layer into a flat configuration.
[0046] According to the solid state camera of this invention, the inside of the 2nd layer is transmitted the 2nd layer, catching optical 17a which carried out incidence from the field in which a lens on chip is not formed by the optical guided wave film 10, and, carrying out multiple reflection of the 1st layer to 11 the 2nd layer for example, by the interface, 12, and 12 and the interface which it is with 13 the 3rd layer, as shown in drawing 1 - drawing 3 . Furthermore, according to the refractive index of each class, transmission of light may take place also in the 1st layer and the 3rd layer. The light transmitted by the optical guided wave film 10 penetrates opening formed in 11 the 1st layer, and is led to a light sensing portion 3. Moreover, similarly, optical 17b reflected on light-shielding film 8 front face is also caught by the optical guided wave film 10, and may be led to a light sensing portion 3.
[0047] In addition, the above optical guided wave film is applicable also to the MOS mold solid state camera equipped with the light sensing portion and the amplifying circuit containing an MOS transistor not only a CCD mold solid state camera but in a pixel. In this case, although the formation part of the optical guided wave film is not limited especially if it is a part which can secure the incidence of the light to the optical guided wave film, forming up is more desirable than the metal membrane for wiring which constitutes the amplifying circuit in a pixel. It is desirable to form an interlayer insulation film so that the metal membrane for wiring and a light sensing portion may be covered especially, to form a crevice in the part corresponding to the light sensing portion of this interlayer insulation film by the photolithography method and etching, and to form the optical guided wave film on it.
[0048]
[Effect of the Invention] As explained above, according to the solid state camera of this

invention, a semi-conductor substrate, It has the light sensing portion formed in said semi-conductor substrate, and the optical guided wave film formed above said semi-conductor substrate. Said optical guided wave film is the multilayers the 1st layer, the 2nd layer, and the 3rd layer come to carry out a laminating to order from said semi-conductor substrate side. When it has the refractive index from which the 1st layer and said said 3rd layer differ in said 2nd layer and said 1st layer has opening into the part corresponding to said light sensing portion at least Since not only the light that carries out incidence from a lens on chip but the light which carries out incidence from other parts can be led to a light sensing portion, the rate of condensing to a light sensing portion improves, and it becomes high sensitivity.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing an example of the structure of the solid state camera concerning this invention.
[Drawing 2] It is the sectional view showing another example of the structure of the solid state camera concerning this invention.
[Drawing 3] It is the sectional view showing another example of the structure of the solid state camera concerning this invention.
[Drawing 4] It is the sectional view showing the structure of the conventional solid state camera.
[Description of Notations]
1 21 Semi-conductor substrate
2 22 Well
3 23 Light sensing portion
4 24 Charge transfer section
5 25 Insulator layer
6 26 Transfer electrode
7 27 The 1st interlayer insulation film
8 28 Light-shielding film
9 29 The 2nd interlayer insulation film
10 Optical Guided Wave Film
11 1st Layer
12 2nd Layer
13 3rd Layer
14 34 Flattening film
15 35 Color filter
16 36 Lens on chip
17a, 17b, 37 Incident light
30 Passivation Film